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News Beat

DOE Evaluates "Marginal Properties" in the Gulf of Mexico–An Important Public Policy Analysis to Encourage Domestic Oil & Gas Production

The DOE National Energy Technology Laboratory (NETL) has completed a comprehensive evaluation of "marginal properties" in the Gulf of Mexico. The objectives of the study are twofold: 1) develop a methodology to predict when the existing oil and gas leases are expected to reach their economic limit of production, and 2) determine what impacts specified economic incentives, in terms of Federal royalty relief, will have in extending the economic life of these leases, thereby maximizing their production.

Offshore operations in the Gulf of Mexico.

The NETL conducted this analysis in direct response to a joint request from the Independent Petroleum Association of America (IPAA) and National Oceanic Industry Association (NOIA). The entire analysis was completed in close consultation with a peer review committee with participants from three operating companies (Devon Energy, Forest Oil, and EOG Resources), the American Petroleum Institute (API), and the Petroleum Technology Transfer Council (PTTC). Representatives from the Minerals Management Service (MMS) also attended all the peer review meetings. It is important to note that the findings and conclusions of this analysis doesn't necessarily reflect the views of the MMS. The results presented in this report are not intended to propose any royalty relief mechanisms, but only to evaluate the potential impacts of selected scenarios.

Why is this important? The oil and gas resources in the Gulf of Mexico are massive with significant contributions to the nation's energy supplies. It is currently the largest producing area in the United States and is the source for about 20% of the total U.S. oil and gas production. There are 7,564 oil and gas active leases in the Gulf of Mexico. These leases are located beyond the three-mile limit of the Federal-state line and extend up to 200 miles into the Gulf. A total of 3,628 of these leases are in water depths of 200 meters or less. Collectively these shallower leases account for about 50% of the oil production and 75% of the total gas production in the Gulf.

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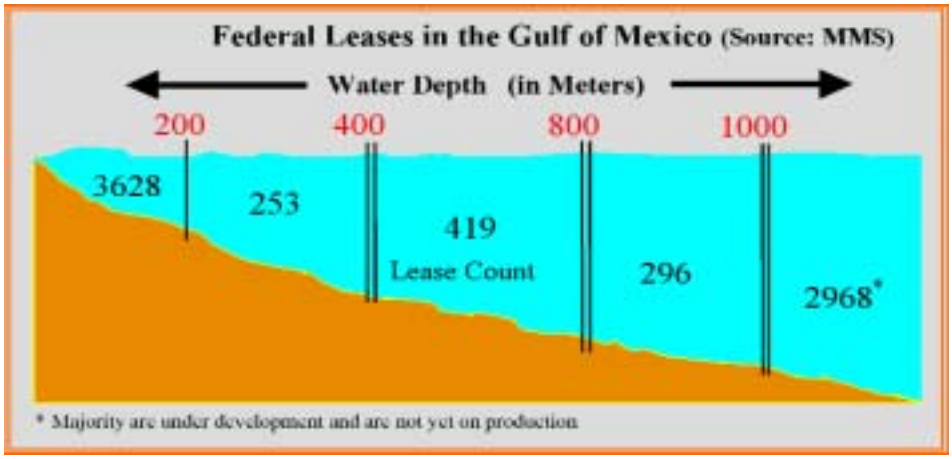


A large number of these shallower leases are likely to reach their economic limit over the next few years for a variety of reasons, including but not limited to: 1) resource maturation, 2) unfavorable oil and gas prices, and 3) the absence of cost-effective recovery techniques to pursue the remaining oil and gas in place. Once these leases reach their economic limit of operation, the production will be curtailed, all the in-place infrastructure is removed, wells will be plugged and abandoned, and leases will expire.

Assuming the economic conditions do not justify their continued operations, the access to such a valuable public resource will be lost. Furthermore, the lost oil and gas production will most likely be replaced by more imports with negative impact on America's long-term energy security.

It is imperative to devise and implement "smart" approaches in order to maximize recovery from these existing and future leases, prolong their economic life, and delay abandonment for as long as possible in order to avoid additional imports, and thus insure a more stable and secure energy market for our citizens. This could only be accomplished through concerted and targeted efforts by industry, states, and Federal agencies in the areas of research and development, economic incentives, and regulatory reforms – all which are consistent with the Bush Administration's National Energy Plan.

Why DOE? DOE has within its mission the goal of assuring clean, affordable, and dependable supplies of energy for our Nation. And one very important area supporting this goal is providing science-based information and analysis for legislative, regulatory, and policy decision making that affects U.S. oil and gas supply and fuel availability. Over the past 20 years, DOE has developed a unique suite of oil, gas, and pro-grammatic models and the required expertise to evaluate potential economic recoveries of domestic oil and gas resources under a wide range of conditions. These models are routinely used to estimate the cost and potential benefit of different technologies, economic criteria such as taxes and royalties, and legislative and regulatory environments. The DOE's models, among others, include the Total Oil Recovery Information System (TORIS) and the Gas System Analysis Model (GSAM). The IPAA, with NOIA, knew of this capability and asked DOE to use its expertise to assess reasonable royalty relief scenarios for the Gulf of Mexico.

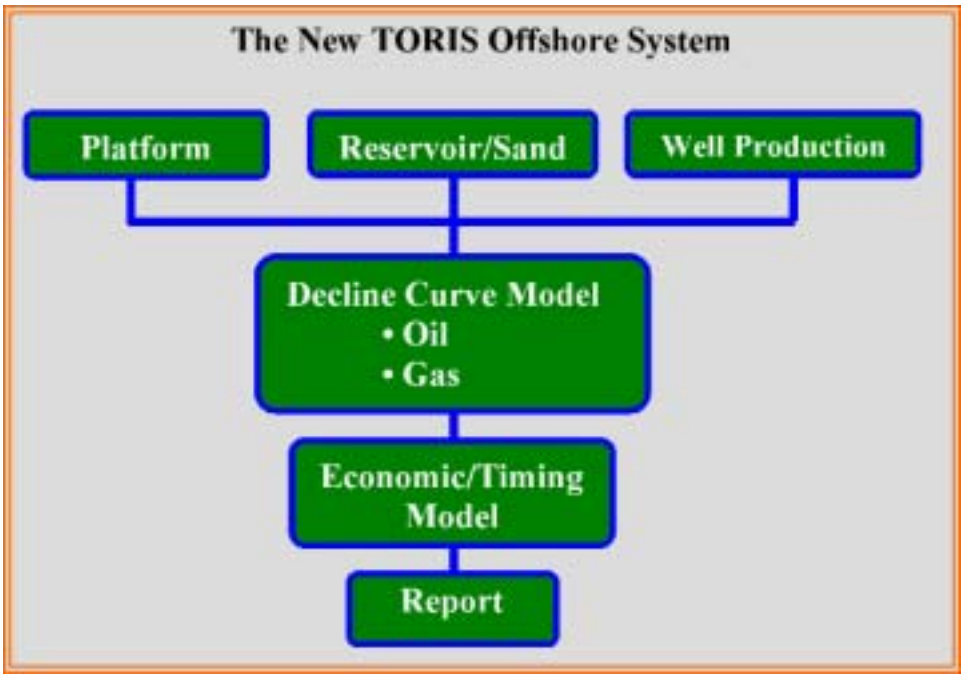
The DOE's role in this effort is limited to providing all required sensitivity analyses to allow IPAA and others to evaluate royalty relief scenarios. To this end, the NETL acts as an "honest broker" for the analysis. The MMS of the Department of Interior has management and regulatory authority for all Federal lands in the Gulf of Mexico and is the agency that approves and implements any royalty relief scenarios.

Analytical Approach

The analysis presented in this report is based on a comprehensive study using DOE's analytical capabilities. The system represents the disposition of the total existing oil and gas resources in the Gulf of Mexico for all leases in 200 meters or less water depth. It represents all completions producing and active as of December 31, 1999. All producing completions were matched with platform, borehole and reservoir databases. The TORIS Decline Curve Model was used to match existing and pre-

dict the future recovery potential from all producing completions. Their production profiles were then aggregated to the "lease" level for economic analysis. The economic model used the prediction to calculate the economic limit and provide all required sensitivity analyses. The results of individual leases were then aggregated to the study area (water depth of 200 meters or less) in the timing model.

The DOE formed a peer review committee to guide the entire offshore study through its development and analysis phases. The members were selected from industry experts in offshore operations, members of industry associations, the MMS and the DOE. The Committee's qualifications included expertise in the areas of reservoir engineering, production engineering, field operation, reservoir modeling, and project economics. The committee held a number of review meetings and provided significant contributions to the accuracy and the overall quality of this very important public policy analysis.



What is a "Marginal Property"?

Definition of "marginal property" was an important part of this analysis. Unlike onshore properties where a marginal well is defined as a well that produces less than or equal to fifteen barrels of oil per day or equivalent, no known analysis has ever been done to define an offshore marginal property. To define such a property, two major questions had to be answered: 1) what is the unit of analysis, and 2) when does a property reach its marginal status?

First, several units of analysis were contemplated by the peer review committee during the course of this study: well, platform, lease, and field. Based on the current operations in the Gulf of Mexico, it became apparent that all contracts, production accounting, and royalty payments etc. are conducted at a lease level. Therefore, based on the stated reasons, "lease" was chosen as the unit of economic analysis.

Second, a lease reaches its economic limit of production when revenues are equal to cost. When the economic limit of production is reached, the operator may continue to produce uneconomically or shut-in the lease. It is important to note that the present analysis focuses on the economic limit time (not shut-in or abandonment time) as the basis for the definition of "marginal lease". Moreover, arguments can be made that at the time of economic limit the leases are not generating any profit and cannot truly be considered as "marginal". Therefore, for sensitivity analysis purposes, this analysis focuses on two additional periods earlier than the time for economic limit. They are: 1) time when revenue is 5% greater than cost, and 2) time when revenue is 10% greater than cost.

Using the above criteria, the economic limit of each lease was defined at four different oil and gas prices, ranging from $16 to $28 per barrel ($/Bbl) of oil and $ 1.95 to $3.64 per thousand standard cubic feet of gas ($/MCF). All leases with water depths of 200 meters or less were considered for this study. Then, statistical correlations were developed to define the lease's pro-

duction rate at the time of economic limit, or earlier depending upon the sensitivity analysis scenario, as a function of simple and readily available information such as water depth, number of wells, total depth, number of complexes (platforms), and oil and gas prices.

Each correlation had a strong statistical significance. The R^2 for the correlations for oil leases was about 0.947 for all three cases and it was 0.938 for gas leases. These correlations provide the ability for royalty relief scenarios to be applied on an area-wide basis as the surrogate equations use simple, easily obtained and defined data to calculate the production rate where royalty relief can be granted.

What Type of Royalty Relief?
At present, all Federal oil and gas leases in shallow water are subject to a royalty rate of 1/6th of gross production. DOE, in this analysis, evaluated the cost and benefit of two royalty relief cases: 100% relief at "marginal lease" conditions and 50% relief where the operator would pay 1/12 royalty on all oil produced up to shut in.

In order to study the effectiveness of such royalty relief scenarios, a "Base Case" had to be developed for comparison purposes. The following assumptions were used in defining the Base Case: 1) no royalty relief, and 2) lease stops production when the revenue is equal to the cost.

Definition of Marginal Lease

For Oil Leases (GOR < 5,000 Scf/Bbl)

$$MBOE = b1 \times \left(\frac{1}{OP}\right) \times WC + b2 \times TD + b3 \times WD \times CC$$

For Gas Leases (GOR > 5,000 Scf/Bbl)

$$MMCFE = b1 \times \left(\frac{1}{GP}\right) \times WC + b2 \times TD + b3 \times WD \times CC$$

Where:
MBOE = Oil & Gas Production for an Oil Lease at Economic Limit Stated (MBOE/Yr)
MMCFE = Gas & Oil Production for a Gas Lease at Economic Limit Stated (MMCFE/Yr)
WC = Productin Well Count
WD = Water Depth (Meters)
OP = Oil Price ($/Bbl)
GP = Gas Price ($/Mcf)
CC = Complex Count
API = Oil Gravity
TD = Total Depth (Feet)

Constants	Oil (GOR < 5000)			Gas (GOR > 5000)		
	1.00*	1.05*	1.10*	1.00*	1.05*	1.10*
b1	1008.8	1070.7	1124.2	1228.4	1279.2	1338.6
b2	0.000359	0.00357	0.00355	0.00905	0.00922	0.00975
b3	0.933	0.889	0.93	4.729	5059	5.061
R^{2**}	0.949	0.949	0.947	0.938	0.938	0.938

*-Rev/Cost Ratio

In the royalty relief cases, for periods when the production was greater than the economic limit production defined by the statistical correlation, the royalty rate was set to 1/6th (full royalty). When the production dropped below the economic limit, the royalty rate was either reduced to zero or to 1/12th depending on the royalty relief case. All other assumptions and considerations were the same as the "Base Case". The study parameters included: 1) Incremental production defined as the additional production stimulated by the royalty relief cases, and 2) Cost/Benefit to Treasury, defined as royalties foregone divided by incremental production. A positive number indicates a cost to Treasury, whereas a number enclosed within parentheses indicates a gain to the Treasury. All cost and benefits, in this analysis, are stated in two terms:

- In Terms of Oil: Oil and gas production for all leases con-verted to Millions of Barrels of Oil Equivalent (MMBOE).
- In Terms of Gas: Oil and gas production for all leases converted to Billions of Cubic Feet of Gas Equivalent (BCFE).

Moreover, a maximum benefit and a minimum benefit scenario were established in order to bracket the impact of the royalty relief cases.

Maximum Benefit Scenario

This case is defined to show the relative impact of the incentive among the cases analyzed. For the 100% royalty relief case, the total incremental production over the next 20 years ranges from 401 MMBOE at $16/Bbl to 455 MMBOE at $28/Bbl or in terms of gas, about 2,249 BCFE to 2,550 BCFE across the analyzed gas prices. This net gain in production amounts to about a 9 percent average increase in recovery over the base case. The incremental production remains the same for all three revenue to cost ratios. This emphasizes that the royalty relief granted earlier than the economic limit time, while improving profit,

Maximum Benefit Scenario

Rev/ Cost	Oil Price ($/Bbl)	Gas Price ($/Mcf)	100% Royalty Relief				50% Royalty relief			
			Incremental MMBOE	Cost $/BOE	Incremental BCFE	Cost $/MCFE	Incremental MMBOE	Cost $/BOE	Incremental BCFE	Cost $/MCFE
1.00	$16	$1.96	401	$0.00	2,249	$0.00	275	($1.09)	1,542	($0.19)
	$20	$2.25	424	$0.00	2,379	$0.00	277	($1.31)	1,551	($0.23)
	$24	$2.81	454	$0.00	2,545	$0.00	303	($1.65)	1,700	($0.29)
	$28	$3.64	455	$0.00	2,550	$0.00	309	($2.09)	1,734	($0.37)
1.05	$16	$1.96	401	$0.12	2,249	$0.02	275	($1.00)	1,542	($0.18)
	$20	$2.25	424	$0.23	2,379	$0.04	277	($1.13)	1,551	($0.20)
	$24	$2.81	454	$0.25	2,545	$0.04	303	($1.46)	1,700	($0.26)
	$28	$3.64	455	$0.39	2,550	$0.07	309	($1.81)	1,734	($0.32)
1.10	$16	$1.96	401	$0.30	2,249	$0.05	275	($0.87)	1,542	($0.16)
	$20	$2.25	424	$0.47	2,379	$0.08	277	($0.95)	1,551	($0.17)
	$24	$2.81	454	$0.46	2,545	$0.08	303	($1.31)	1,700	($0.23)
	$28	$3.64	455	$0.77	2,550	$0.14	309	($1.53)	1,734	($0.27)

will have no effect in extending the economic life, and thus will not yield any incremental production. And the forgone royalty results in a net cost to the Treasury. In the 50% royalty relief case, however, the analysis indicates that up to 309 MMBOE (or 1,734 BCFE) of incremental production are possible at no cost to the Treasury. In fact, the incremental production will generate more royalties than the amount foregone and will produce a net gain to the Treasury. This gain could be as high as $2.09/BOE (or $0.37/MCFE) across the analyzed cases. The incremental production is an average increase of about 6 percent over the base case.

Minimum Benefit Scenario

This case was designed to show the impacts of both the incentives and the use of correlations for determining the production rate at the economic limit. For the 100% royalty relief case, the total incremental production ranges from 286 MMBOE at $16/BBl to about 317 MMBOE at $28/BBl over the next 20 years. And in terms of gas, the production ranges from 1,478 BCFE up to 1,828 BCFE across the analyzed gas prices. This represents an average increase of about 6 percent over the base case production. The cost to Treasury ranges from $0.91 to $3.96/BOE or from $ 0.16/MCFE to $0.71/MCFE for the analyzed cases.

The incremental production in the 50% royalty relief case is about half of the potential incremental production from the 100% royalty relief case. The incremental production here is also produced at a lesser cost to the Treasury as compared to the 100% relief case. At a revenue to cost ratio of 1.00, the 50% royalty relief case actually benefits the Treasury by as much as $0.35/BOE (or $0.06/MCFE). At the higher revenue to cost ratios of 1.05 and 1.10, there is cost associated with the incremental production. This is because the amount of royalties foregone (which were otherwise collected) is more than the amount of royalties collected. In this specific case, the average incremental production is about 3 percent above production estimated in the base case.

Limitations of the Analysis

As with any analysis of this type, the reader needs to remind themselves that many assumptions are made to permit the analysis of thousands of leases to be performed. Based upon this, the cost and benefit estimates should be considered as "potential" and not as "forecast" of the likely future impacts. Several factors would cause the future actual impacts to be different from those presented in this report:

- The analysis is based on existing wells and completions producing as of December 31, 1999. Those recompleted or drilled after this date are not included in the analysis.

• The results of the royalty relief cases reflect successful implementation of the relief program. Also the success of this program will depend on the usage of the program by the operators.

• The economic analysis assumes average platform operating costs. Actual operating costs will depend on the operator and the exact type of infrastructure in use.

• The economic model assumes annualized workover costs instead of actual costs used at various times during the life of each well.

• The economic analysis also assumes that prices remain stable during the life of the lease. Price volatility could have a greater effect on the profitability of the analyzed leases than the royalty relief scenarios contemplated.

• The economic limit defined in this analysis reflects the time when the revenue is equal to cost. This is not a predictor of when the lease is shut-in or abandoned. Some operators may actually shut-in leases at earlier or later times depending on various technical or economical reasons.

• The statistical correlations are intended to provide an approximate indication of the economic limit and are not intended to predict when the leases are shut in or platforms are abandoned.

Collectively, these factors will more than likely cause the future actual impacts of the royalty relief programs to be different from the estimated potentials.

Summary

The oil and gas reservoirs in the Gulf of Mexico contribute up to 20% of the total production in the United States with a significant portion of this resource being located in water depths of 200 meters or less. Reasonable royalty relief scenarios can potentially boost production from 3 to 9 percent from the leases located in the shallower waters in the Gulf of Mexico. The analysis of alternative Federal royalty structures presented in this report leads to the following major conclusions:

• Simple correlations have been developed to define marginal leases in the Gulf of Mexico (< 200 meters).

• Use of statistical correlations have some impact in the overall cost and benefit of the incentive.

• With targeted royalty relief, additional production of up to 2.5 TCFE or 455 MMBOE is possible.

• The cost or gain to Treasury depends very strongly on the extent of the royalty relief and its implementation criteria.

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Minimum Benefit Scenario

Rev/ Cost	Oil Price ($/Bbl)	Gas Price ($/Mcf)	100% Royalty Relief				50% Royalty relief			
			Incremental MMBOE	Cost $/BOE	Incremental BCFE	Cost $/MCFE	Incremental MMBOE	Cost $/BOE	Incremental BCFE	Cost $/MCFE
1.00	$16	$1.96	286	$0.91	1,604	$0.16	160	($0.24)	897	($0.04)
	$20	$2.25	308	$1.03	1,725	$0.18	160	($0.29)	898	($0.05)
	$24	$2.81	326	$1.34	1,828	$0.24	175	($0.36)	983	($0.06)
	$28	$3.64	317	$1.85	1,780	$0.33	172	($0.35)	964	($0.06)
1.05	$16	$1.96	264	$1.44	1,478	$0.26	149	$0.22	838	$0.04
	$20	$2.25	280	$1.77	1,572	$0.32	142	$0.47	795	$0.08
	$24	$2.81	307	$2.26	1,720	$0.40	161	$0.55	905	$0.10
	$28	$3.64	305	$2.97	1,710	$0.53	162	$0.74	912	$0.13
1.10	$16	$1.96	267	$2.05	1,498	$0.37	150	$0.78	840	$0.14
	$20	$2.25	274	$2.43	1,539	$0.43	139	$1.11	779	$0.20
	$24	$2.81	303	$2.96	1,701	$0.53	160	$1.20	899	$0.21
	$28	$3.64	308	$3.96	1,729	$0.71	164	$1.66	923	$0.30

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Three New Projects Selected for Grants in DOE's "Technology Development with Independents" Program

With America's oil production increasingly being supplied by small independent producers, the U.S. Department of Energy is continuing its efforts to help the smallest of these companies test higher-risk technologies that could keep oil flowing from thousands of marginal wells.

The department added three more projects to its **"Technology Development with Independents Program."** Since 1999, this program has provided small businesses in 13 states – each with less than 50 employees – the financial backing to test new techniques that might otherwise have remain untried.

The program is one of several initiatives in the Energy Department's fossil energy program that is working to slow or halt the decline in U.S. oil production. Today, small independent businesses account for 50 percent of domestic petroleum production in the lower 48 states. Most are facing increasing economic and technical difficulties associated with harder-to-recover resources.

The Department's Fossil Energy Oil Technology Program provides matching grants of up to $75,000 to companies willing to apply innovative approaches that can lower operating costs and extend the life of marginally producing fields. Companies that achieve success in prolonging the productive life of their fields convey the techniques to other small producers facing similar difficulties.

This round of selected projects includes:

Benson-Montin-Greer Drilling Corporation, Farmington, NM, will use new log interpretation methods based on artificial intelligence and neural networks to evaluate oil well recompletion opportunities in the Mesa Verde formation of New Mexico's San Juan Basin.

American Energies Corporation, Wichita, KS, will design and implement a low-cost, effective waterflood in the Mississippian formation of the Wellington West Field, Sumner County KS, that demonstrates application of inexpensive but modern tools to build an integrated reservoir model, based on geologic, geophysical, and engineering characterization techniques.

Beard Oil Company, Dewey OK, will install and test a new type of low-volume submersible pump to evaluate its ability to lower operating costs in a typical low-production marginal oil field. Ten new submersibles will be compared with ten conventional rod pumps in a test of comparative pump efficiencies and operating costs. The Energy Department is encouraging other small companies to apply for future rounds of technical assistance grants. Producers have until **December 24** to submit applications for the final rounds of the current program. The program is funded through the department's National Energy Technology Laboratory. The Laboratory's petroleum research arm, the National Petroleum Technology Office in Tulsa OK, evaluates the applications and manages the projects.

Details of the Technology Development With Independents program are available at http://www.npto.doe.gov/indep

For project technical information, contact: Jim Barnes, 918-699-2076; e-mail: Jim.Barnes@npto.doe.gov

For more information on how to submit proposals for the final round of the "Technology Development With Independents" by December 24, go to the NPTO website at **www.npto.doe.gov/Business/procure.html**

DOE to Help Develop New Tools for Increasing Domestic Oil Production

America's best hope for slowing or perhaps halting the decline in domestic oil production may be new technologies that locate oil previously missed, produce oil that today's processes leave behind, and ensure that tomorrow's producers can meet strict environmental standards.

With the President's National Energy Policy calling for continued public-private partnerships to develop new oilfield technologies, the Department of Energy plans to add 12 new projects in three categories to its ongoing petroleum research program.

The projects were selected in the first round of a broad-ranging solicitation issued last December by the department's Office of Fossil Energy. Another round of project winners will be announced later this year.

The projects named today will be managed by the National Petroleum Technology Office in Tulsa, Oklahoma, the oil research arm of the Energy Department's National Energy Technology Laboratory. The office oversees a cooperative program with industry and universities to develop improved technologies that can extend the life of marginal fields and improve access to the billions of barrels of unproduced oil remaining in the Nation's reservoirs.

The selected oil-related research projects are listed below under their technology topic areas:

Oil Technology: Reservoir Efficiency Processes

This area addresses the need to access oil not recoverable by conventional methods by developing improved methods of gas, chemical and microbial flooding for light oil recovery.

New Mexico Institute of Mining and Technology, Socorro, NM, will study ways to improve processes for injecting carbon dioxide into oil reservoirs to force out oil that remains trapped after conventional recovery processes are completed. Researchers will attempt to improve the "sweep efficiency" of CO_2 floods – i.e., the extent to which the CO_2 spreads out as it moves through the reservoir – and examine a technically advanced approach that combines CO_2 and foam to improve the effectiveness of CO_2 flooding. A successful project will result in more efficient CO_2 flooding and expand the range of reservoirs amenable to CO_2 flooding.

The project contact is Dr. Reid B. Grigg at 505-835-5403.

Texas Engineering Experimental Station (TEES), Texas A&M, College Station, TX, will examine artificially fractured cores of reservoir rock using X-ray Computerized Tomography. The objective is to determine why CO_2 often bypasses oil in reservoirs that are naturally fractured or in which producers have created fractures. The results will be applied to achieve a more efficient CO_2 flood and reduce the amount of oilbeing bypassed in fracture-dominated reservoirs.

The project contact is Dr. David Schechter at 979-845-2275.

University of Kansas, Lawrence, KS, will develop polymer gel systems that will penetrate deeper into the reservoir and are specially formulated to reduce the amount of water that is often produced along with oil. Polymer gels are thick solutions made up of long-chained chemical molecules that are injected into a reservoir to break oil droplets loose from surrounding rock and move them through a reservoir. The use of polymer gels has been limited because current

gels do not have the ability to penetrate long distances into the reservoir. Developing better polymer gel treatments will not only improve their effectiveness in producing oil but also help the environment by reducing the amount of produced water brought to the surface.

The project contact is Dr. Paul Willhite at 785-864-2906.

California Institute of Technology, Pasadena, CA, will develop low-cost surfactants – a soap-like chemical – that can reduce the tendency of oil droplets to cling to surrounding rock. A special focus of the project will be to develop surfactants that can tolerate high concentrations of salty brines that exist in many U.S. oil reservoirs.

The project contact is Dr. Yongchun Tang at 909-468-9310.

Critical Upstream Advanced Diagnostics and Imaging Technologies

Technologies in this area address the need for improvements in the way geophysical data are acquired, processed and interpreted. This can help increase producers' ability to measure the properties of reservoir rock and tailor oil recovery methods to be most effective in a specific type of reservoir. These technologies could also improve the ability to predict the results of advanced oil recovery processes, especially important in making economic decisions to apply higher-risk technologies.

Advanced Resources International, Houston, TX, seeks to advance the state of measurement, processing and interpretation technologies primarily by tying together data obtained on a broad scale from 3-dimensional seismic technologies and on a smaller scale from individual well logs. Integrating this data could lead to seismic technologies that have much greater resolution than today's state-of-the-art systems.

The project contact is Scott Reeves, at 713-780-0815.

Rock Solid Images, Houston, TX, will develop new tools for measuring reservoir properties that will combine the latest understanding of how the inelastic nature of rocks is influenced by rock type, the microstructure of pores throughout the rock, and the type of fluid that fills the pores. Researchers will study how changes in seismic signals can be calibrated to well log information and used to pinpoint the bestlocations for drilling wells.

The project contact is Dr. M. Turhan Taner at 713-783-5593.

The University of Texas at Austin, Austin, TX, will focus on a category of oil reservoirs, called "turbiditic reservoirs," formed in the deep Gulf of Mexico. Although these reservoirs could be likely sources of new U.S. petroleum reserves, oil production is difficult and expensive. University researchers will develop a new method they hopewill reveal more accurate information on the characteristics of the rock layers that make up these reservoirs. Based on computer simulations of how sediment-laden flows deposited the sand and silt that ultimately formed these reservoirs, the researchers hope to construct a profile of an entire reservoir and use it to run simulations of various oil recovery processes.

The project contact is Roger Bonnecaze at 512-471-1497.

The **Pennsylvania State University**, State College, PA, will study how changes in the stress levels inside an oil reservoir can affect the way oil and other fluids move through reservoir rock. Fractures in reservoir rocks often allow oil and gas to move more easily to production wells, but fractures can also short-circuit production when they divert fluids away from the desired pathways. Researchers will use X-ray Computed Tomographic (CT) imaging to study how pressures that hold fractures open inside an oil reservoir decline as oil is produced, and how stress levels in the rock buildup and often force fractures to close.

The project contacts are Abraham S. Grader at 814-865-5813, Phillip M. Halleck at 814-863-1701, or Derek Elsworth at 814-865-7659.

Bureau of Economic Geology,

The University of Texas at Austin, Austin TX, will focus on carbonate oil reservoirs common to the Permian Basin of West Texas and elsewhere in the U.S. Data from a Permian Basin reservoir will be compared to geologically similar outcrops in the Sierra Diablo mountains of West Texas, and a high resolution, more geologically realistic computer model of the reservoir will be developed. Companies will be able to use to the model to determine the best way to apply such technologies as horizontal wells, CO_2 injection, infill drilling (drilling between existing wells), and other oil recovery methods.

The project contact is Stephen Craig Ruppel at 512-471-2965 or ext.1534.

Stanford University, Palo Alto, CA, will focus on understanding better the "signatures" of seismic waves at the microscopic level in reservoir rock. Using a technique called "Acoustic Miscroscopy," researchers will use sound waves to map and quantify the microstructure of oil-bearing rocks, measuring how the acoustic signals are changed as they move through and across the individual grains that make up the rocks. Integrating knowledge about a reservoir rock's microstructure will an understanding of the sedimentary processes that formed the rock, and the elastic properties of the rock will allow oil producers to better interpret seismic images and to link geologic models to the actual oil-producing properties of a reservoir.

The project contact is Dr. Gary Mavko at 415-723-9438.

University of Houston, Houston, TX, will study ways to improve the resolution of "vertical seismic profiling" (VSP). VSP measures the velocities of sound waves in rock layers from inside a well. A seismic source is positioned on the surface next to a well, and a geophone inside the borehole is raised to measure seismic signals at various depths. VSP provides higher resolution images that techniques that rely solely on surface techniques to measure seismic reflections. University researchers will team with an independent oil and gas company in tests over an onshore Louisiana salt dome.

The project contact is Dr. Kurt Marfurt at 713-743-9119.

Oil Technology: Oil & Gas Environmental

This area addresses the need for reducing compliance costs and improving environmental performance by providing lower-cost compliance technologies, providing a sound scientific basis for cost-effective, risk-based regulatory decisions, and improving access to public lands and sensitive environments by demonstrating environmentally protective technologies.

Ground Water Protection Research Foundation, Inc., Oklahoma City, OK, will make available to industry its Risk-Based Data Management System for oil and gas production- and injection-related activities to streamline permitting on state and federal lands, reduce the cost of environmental compliance, and develop user-friendly, on-line reporting techniques.

The project contact is Ben Grunewald at 405-516-4972.

National Petroleum Technology Office Project Technical Contacts:

Reservoir Efficiency Processes: Jerry.Casteel, 918-699-2042; email: Jerry.Casteel@npto.doe.gov

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PUBLICATIONS

For a subscription to the ***Inside*** **Tech Transfer** or any other DOE newsletters, or if you would like back issues, please contact Bernadette Ward at 918/699-2033; email: Bernadette.Ward@npto.doe.gov

Inside **Tech Transfer** is a bi-annual newsletter published since 1995, highlighting projects sponsored by the U.S. Department of Energy and managed through the National Petroleum Technology Office, the research arm of the National Energy Technology Laboratory.

The Class Act
Highlights of the DOE's Reservoir Class Program

Eye on Environment
DOE's Oil & Gas Environmental Research Program

Downstream Details
The National Petroleum Technology Office's Downstream Projects

The Publications List
Computer Software, Supporting Documentation, Reports, and more!

Inside Tech Transfer

The *Inside* Tech Transfer newsletter covers outreach activities of the Department of Energy's National Energy Technology Laboratory's Oil and Gas R&D program.

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"New Cost-Effective Plugging and Adandonment Technique" Demonstrated at DOE-Sponsored Workshop

About the Workshop

A DOE-sponsored workshop held **September 18, 2001** with the cooperation of the Osage Nation and Cementing Solutions Inc. demonstrated a simple, fast, and economical way to plug and abandon wells. The workshop began at **Osage Tribal Headquarters** in **Pawhuska, Oklahoma** at 9:00 a.m. and then moved to a selected wellsite in Osage County where the demonstration took place. More than 160 participants from industry, government, and the Osage Nation attended the workshop. Among those were regulators, small operators, and tribal leaders and members.

About the Technology

Cementing Solutions Plugging Process (CSPP) is a new technique that simplifies the plugging process and involves filling the entire wellbore with cement or placement of discrete plugs in the casing. The use of common construction cement equipment eliminates the need for complex mixing equipment, high-pressure pumping equipment, and a workover rig.

When the mixed slurry is transported to the location, it is discharged from the ready mix truck into a holding tank and transferred to the well via low-pressure pump. Once in the well, the increased hydrostatic pressure exerted by the cement column forces the well fluid into the formation, allowing the cement plugs to be placed at the appropriate locations.

The CSPP integrates regulatory requirements for plug placement and performance; well data (casing sizes, depths, perforations, and well fluids); and formation parameters (pore pressure, breakdown pressure, and permeability). The process is applicable to a wide range of well types, including stripper wells.

For More Information

Information about this or future workshops is available on the National Petroleum Technology Office website at http://www.npto.doe.gov or you can contact Virginia Weyland by phone at 918.699.2042; fax at 918.699.2005; or email: Virginia.Weyland@npto.doe.gov.

The Department of Energy's (DOE) **Native American Initiative** is designed to enable American Indians to develop and manage their energy resources. This program seeks ways to empower American Indian communities to prosper by funding projects that develop and apply the latest technological innovations. The DOE partners with tribes, industry and other government agencies to increase oil recovery on tribal lands while effectively protecting the environment. Program activities are expected to return economic dividends to the tribes at the same time it helps to strengthen our country's energy security.

E-News

Risk Analysis and Decision Making Software Available from NPTO

Neuro3

Neuro3 - Neural Network Software: Neural networks are systems that are constructed to use some organizational principles resembling those of the human brain. They are information-processing systems that demonstrate the ability to learn, recall, and generalize from training patterns or data. They are good at tasks such as pattern matching and classification, data clustering, and forecasting. Common oil and gas applications include forecasting of reservoir properties from wireline log signatures, extension of reservoir properties for simulation, and seismic interpretation. While this application was written for the oil and gas community, it is generic enough to apply to any problem for data-mining, correlation, or categorization needs. The application is a 32-bit MS Windows application. It contains an extensive help system with a tutorial and background information on neural networks. The application also has a spreadsheet interface to allow import and export of external data sets.

TREE2000-Decsison Tree

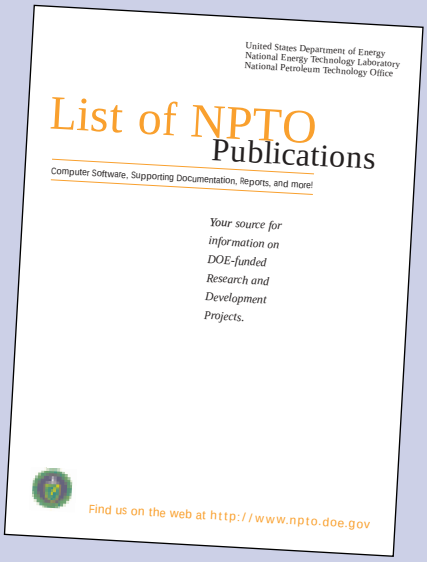
TREE2000-Decision Tree Software: Decision tree software embodies a highly customizable tool for risk management and informed decision making. Variables such as price, production, and operating costs contain unknowns that must be accounted for when looking at the value of a given decision or project.

Decision tree software allows you to apply all the information you have on various unknowns and give you the "big picture" of the situation, showing how that information affects your future and current choices. This assistance will illustrate possible outcomes of decisions and better inform you of where to invest effort in reducing uncertainties. The application is a 32-bit MS Windows application. It contains a help system with an example and background information on decision tree construction.

On-line sources

For the latest software, CDs, reports and more, visit the NPTO website at www.npto.doe.gov

For a complete listing of reports, CDs and software available from NPTO go to www.npto.doe.gov/PubList88.pdf



Who's Who

DOE Researcher Selected for Distinguished SPE Award

**Abbass Firoozabadi,
Professor Reservoir Engineering
Research Institute**

A DOE Oil Program Researcher, Abbas Firoozabadi, has been selected by the Society of Petroleum Engineers to received its most distinguished technical award–the Anthony F. Lucas Award. Dr. Firoozabadi, a senior scientist and director of the Reservoir Engineering Research Institute (RERI) in Palo Alto, California, has conducted research on modeling the behavior of fractured reservoirs for the DOE Fossil Energy program for many years. He teaches at Imperial College in London, and at Stanford University and the University of Texas–Austin.

Dr. Firoozabadi is internationally known for his work on thermodynamics of hydrocarbon reservoirs and production, and multiphase flow in fractured media. He has authored a graduate-level text in hydrocarbon reservoirs published by McGraw-Hill in 1999 and has authored or co-authored more than 100 technical papers. More than 50 of his papers have been published by SPE. He has also published extensively in the American Institute of Chemical Engineers Journal.

Over the past 12 years, work at RERI has resulted in the definition and solution of critical issues of oil and gas production in fractured hydrocarbon reservoirs. During this time, RERI has received support from DOE through the National Petroleum Technology Office and nearly all major oil companies in the United States, Europe, Middle East, Japan, and South America. For his efforts, SPE selected Dr. Firoozabadi for the 2002 Anthony F. Lucas Award–the highest recognition for technical contribution to the advancement of petroleum engineering technology.

DOE Project Aids Industry Research on Capillary Action In Fracture Oil Reservoirs

In 1999, DOE Fossil Energy Oil Program awarded a $400,000 contract to RERI for a period of three years to study a natural force, called capillarity, that is exerted within the tiny, interconnected pores of oil-bearing rock and inside the ribbon-thin fractures that run through an oil reservoir. Capillarity is the reason why a narrow tube inserted into a container filled with water will naturally draw the water up into the tube. The same force operates within the rock pores and natural fractures of an oil reservoir, influencing how fluids move through the reservoir.

Oil producers can use natural fractures as passageways through which oil is channeled toward a production well. But the behavior and impact of fractures on oil production is hard to predict due to the complex interactions that occur between the reservoir rock and fluids. RERI researchers are using three approaches to study the capillary action and influences of fractured reservoirs:

(1) Researchers are studying how changes in the fracture geometry that controls reservoir pressure, volume and temperature can influence the movement of hydrocarbons present in the reservoir.

(2) Researchers are investigating changes in fractures due to earth tidal forces. The gravitational pull of the moon and sun on the earth causes periodic changes. Most apparent with the ocean tides, these tidal forces can also change the shape and size of fractures. RERI researchers are investigating how these changes occur and the influence they have on the nature and movement of fluids through a reservoir.

(3) Researchers are analyzing how the tendency of a liquid to absorb or spread on the surface of a rock or mineral can influence production. Called wettability, this phenomena can sometimes block the flow of fluids through rock, much the way fatty deposits on an artery wall can block the flow of blood. By finding ways to alter wettability, researchers hope to show how production from reservoirs can be increased.

Researchers are conducting laboratory studies, creating models, and integrating conceptual work with field data from significant oil production formations such as Yates, Austin Chalk, and Ellenberger formations, all in Texas. Results will be incorporated into improved models that expand on previous fracture modeling the RERI did with Golder Associates' Discrete Fracture Network model. The improved models will be used to determine the effect of the various types of fracture networks on the flow of oil and gas through the reservoirs.

The expected results are new tools that more clearly define fracture systems and improved techniques that take advantage of these natural pathways to boost production.

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Inside Tech Transfer

Summer 2001

Resources

Meet Our Tech Experts…

If you are interested in meeting NETL's technical staff, you can do so by stopping by the booth at any of the following meetings or go to the NPTO website at **www.npto.doe.gov:**

October

SPE, Society of Petroleum Engineers Annual Technical Conference, October 1-3, 2001, New Orleans, LA. NPTO booth No. 2639. Contact: Helen Bresson, 918/699-2014; email: Helen.Bresson@npto.doe.gov

Stripper Well Consortium, Oklahoma Marginal Well Commission and Liz Fajen will host a meeting October 23, 2001 in the Zoo Educational Center, Oklahoma City, OK. Contact: Liz Fajen, 1-800-390-0460; email: lfajen@mhs.oklahosf.state.ok.us

PTTC Traveling Workshop Series, beginning October 30, 2001, Jackson, MS. Contact: Lance Cole, 918/241-5801; email: lcole@pttc.org

LAGCOE, Louisiana and Gulf Coast Oil Exhibition, October 30-November 1, 2001, Lafayette, LA. NPTO Booth No. C17. Contact: Helen Bresson, 918/699-2014; email: Helen.Bresson@npto.doe.gov

Sites To See…

SPE/DOE Thirteenth Symposium on Improved Oil Recovery, www.npto.doe.gov/ior
Technology Development with Independents, www.npto.doe.gov/indep/index.html
NPTO Software, www.npto.doe.gov/software/softindx.html
Reservoir Engineering Research Institute, www.rerinst.org
Native American Initiative, www.npto.doe.gov/Native/index.html